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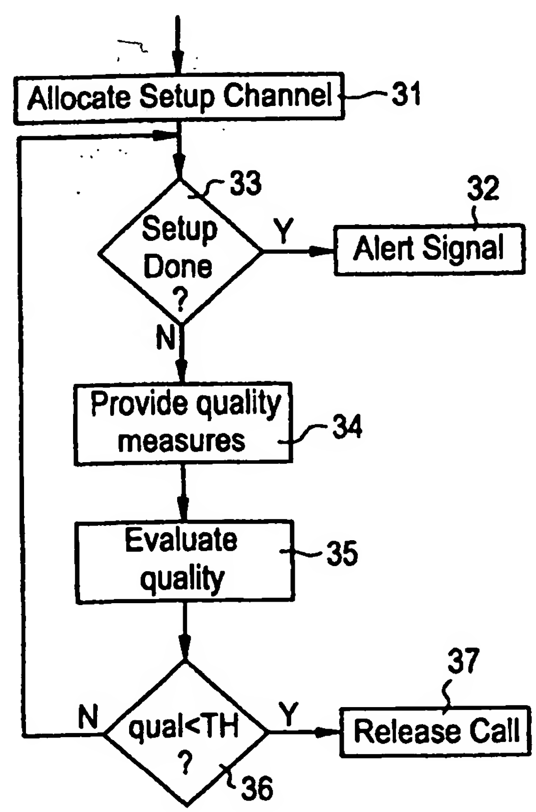
(54) Title: CALL ADMISSION CONTROL IN WIRELESS COMMUNICATION NETWORKS

(57) Abstract

Call admission in a wireless communication network is controlled by obtaining, during setup signaling (33) for a desired call, information indicative of communication quality (34) on the setup signaling channel. This information is used (35, 36) to decide whether to admit the desired call.



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CALL ADMISSION CONTROL IN WIRELESS COMMUNICATION NETWORKS

FIELD OF THE INVENTION

The invention relates generally to admission control in wireless communication networks, and, more particularly, to measurements and criteria used in making admission decisions.

BACKGROUND OF THE INVENTION

In conventional wireless communication networks, for example cellular telephone networks such as GSM (Global System for Mobile Communication), the transceivers are each typically equipped with enough communication channels to accommodate localized traffic peaks at the individual transceivers. Such networks frequently have more total communication channels than can be simultaneously used. As a given transceiver uses more of its channels, the transceiver disadvantageously creates a stronger interference environment with respect to its neighboring transceivers. As this interference increases in strength, a neighboring transceiver can be expected to have correspondingly less of its channels available for use.

It is therefore desirable to provide a way of determining how much additional channel capacity can be used by a given transceiver before (1) the performance associated with channel capacity already in use by other transceivers of the network is unacceptably degraded and (2) the additional channel capacity will have unacceptably low quality. When either of the above-described limits on additional channel capacity is reached, then additional communications (e.g., voice calls or data transmissions) would not be admitted to the network, because the additional channel capacity associated with such communications would have one or both of the above-described disadvantageous effects.

One conventional approach to admission control considers the traffic load associated with the serving transceiver and/or neighboring transceivers. If the traffic load is considered to be too high, then additional communications will not be admitted at the serving transceiver. Using the traffic load at the serving transceiver only will

of course disadvantageously neglect interference caused by traffic at neighboring transceivers. Moreover, even if the traffic load at neighboring transceivers is used, this can only give rough information of when to expect interference problems. Furthermore, using the traffic load from neighboring transceivers implies that a relationship can be established between permissible capacity in the serving transceiver and the traffic load in a defined area surrounding the serving transceiver. Establishing such a relationship is, however, problematic.

Another prior art approach is to monitor the average quality associated with a given transceiver by evaluating measurement reports conventionally sent by the already accepted and thus active mobile stations. Such measurement reports are used to determine, for example, whether a channel change should be made or whether a handoff from one transceiver (or cell) to another should be made. The prior art has recognized that these conventional measurement reports can also be used as an estimation of the average interference level, or conversely the average communication quality, already experienced by the active mobile stations in the cell. If the average quality level is above a certain threshold value in the cell, it is probably possible to admit another communication.

However, and no matter how accurately the interference level already experienced by the active mobile stations can be estimated from the aforementioned measurement reports, the correlation between the interference that already-active connections are experiencing and the interference that new connections will experience may in some cases be very weak. One reason for this weak correlation is that the new connection will usually be made from a different geographical position than the geographical positions of the already-active mobiles, which could render irrelevant any estimation of interference based on the already existing connections.

The present invention recognizes an advantage in obtaining some measure of the actual interference that a newly admitted connection will experience in the network. Besides being indicative of the quality that the newly admitted connection would experience, such a measure can also be expected to be indicative of any performance degradation that the proposed connection will have on existing connections in the network. Accordingly, the invention provides for making the decision of whether or not to admit a newly proposed connection based on an

indication of the actual interference that the newly proposed connection will experience. An indication of an unacceptably high level of interference for the newly proposed connection will result in refusal to admit the communication or call.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURE 1 is a block diagram which illustrates an example of a communication system including a wireless communication network according to the invention.

FIGURE 2 illustrates an exemplary portion of a transceiver controller of FIGURE 1 according to the invention.

FIGURE 3 illustrates exemplary operations of one embodiment of the controller of FIGURE 2.

FIGURE 4 illustrates exemplary operations of a further embodiment of the controller of FIGURE 2.

FIGURE 5, in combination with either of FIGURES 3 and 4, illustrates exemplary operations of further embodiments of the controller of FIGURE 2.

FIGURE 6, in combination with either of FIGURES 3 and 4, illustrates exemplary operations of further embodiments of the controller of FIGURE 2.

FIGURE 7, in combination with either of FIGURES 3 and 4, illustrates exemplary operations of further embodiments of the controller of FIGURE 2.

DETAILED DESCRIPTION

FIGURE 1 is a block diagram of an exemplary communication system including a wireless communication network according to the present invention. In the example of FIGURE 1, a conventional public switched telephone network (PSTN) 11 is coupled to a mobile telephone switching office 13 of a wireless communication network 15. The mobile telephone switching office 13 is coupled to a plurality of transceiver controllers illustrated diagrammatically at 17, which controllers in turn control a plurality of radio transceivers indicated diagrammatically at 19. The transceivers 19 communicate via an air interface 18 with a plurality of mobile transceiver stations (MSs) illustrated diagrammatically at 16. The wireless communication network 15 of FIGURE 1 can be, for example, a GSM network

appropriately modified to include the herein-described features of the present invention. FIGURE 1 illustrates that, in a GSM network, the switching office 13 would correspond to a GSM mobile switching center (MSC), the controllers 17 would correspond to GSM base station controllers (BSCs) and the transceivers 19 would correspond to GSM base transceiver stations (BTSs). It will be evident to workers in the art that the features of the present invention described hereinafter are also readily applicable to other well known wireless communication networks, for example, D-AMPS, PDC, etc.

FIGURE 2 illustrates an exemplary one of the transceiver controllers designated at 17 in FIGURE 1. The example controller of FIGURE 2 includes a setup controller 21, a quality determiner 23 and a measurement storage section 25. In FIGURE 2, only those exemplary portions of the controller 17 that are necessary to understand the present invention are explicitly shown, but it should be understood that the controller 17 will normally also include other conventional portions of a conventional transceiver controller of a conventional wireless communication network. The determiner 23 and/or the measurement storage section 25 can be provided as part of the controller 17, or can alternatively be provided separately from controller 17 and coupled to setup controller portion 21 of controller 17. Moreover, the measurement storage section 25 can be implemented as part of the determiner 23.

The setup controller 21 of FIGURE 2 is responsible for setting up a voice call or other communication between a mobile station 16 and a transceiver 19, whether the call is requested by the mobile station 16 or by the MTSO 13. The setup controller 21 communicates with the MTSO 13 via communication signal path 27, and with one or more transceivers 19 via communication signal paths shown at 29. The measurement storage section 25 also communicates with the transceivers 19 via communication signal paths at 28. The setup controller 21 implements well-known, conventional call setup procedures.

The measurement storage section 25 receives from the transceivers 19 various measurements indicative of communication quality (including interference levels) in the wireless communication network. Such measurements include downlink measurements made by the mobile stations 16 and transmitted to the measurement storage section 25 via the respective transceivers 19, and uplink measurements made

by the transceivers 19 themselves and forwarded to the measurement storage section 25. The measurement storage section 25 thus implements the conventional function of storing measurements of communication quality within the network made by the mobile stations 16 and the transceivers 19.

The setup controller 21 and the measurement storage section 25 are coupled for mutual communication via a communication signal path 26, the measurement storage section 25 and the quality determiner 23 are coupled for mutual communication via a communication signal path 24, and the quality determiner 23 and setup controller 21 are coupled for mutual communication via a communication signal path 22.

When the setup controller 21 receives a request either from the mobile switching office 13 or from one of the mobile stations 16 to set up a call or other communication to or from the mobile station 16, the setup controller 21 typically allocates a control channel, for example, a stand alone designated control channel (SDCCH) in GSM, for handling the setup signaling between the appropriate transceiver 19 and the mobile station 16, as is conventional. In some instances, if there are no available control channels (e.g., SDCCHs), the setup controller 21 can allocate a traffic channel (e.g., TCH in GSM) for the setup signaling, as is conventional. Whether a control channel or traffic channel is allocated for the setup signaling, both the transceiver 19 and the mobile station 16 conventionally perform measurements of communication quality on the allocated setup signaling channel while setup signaling is occurring. For example, the bit error rate (BER) for both uplink and downlink is conventionally measured. In GSM, these quality measurements are typically transmitted from the mobile station 16 to the transceiver 19 on a slow associated control channel (SACCH). The measurements made by the transceiver 19 and the mobile station 16 are relayed by the transceiver 19 to the measurement storage section 25 of the controller 17 via communication signal path 28. As indicated above, all of the above-described channel allocation, setup signaling and quality measurements are conventional techniques which are well known and widely used in wireless communication networks such as GSM. The quality measurements of the setup signaling are conventionally used by the setup controller 21 to determine whether or not to switch to another available channel (for which the

measurement storage section also conventionally includes quality measurements) to continue the setup signaling. The quality determiner 23 of FIGURE 2 obtains from the measurement storage section 25 the quality measurements for the channel currently being used for the setup signaling. The quality determiner 23 evaluates the quality of the communications between the mobile station 16 and the transceiver 19, as indicated by the measurements stored in measurement storage section 25. If the quality determiner determines that the quality is relatively poor, then such determination is taken to indicate that the channel (e.g., SDCCH or TCH) used for setup signaling between the mobile station 16 and the transceiver 19 is relatively highly interfered with by other existing connections between other mobile stations and their associated transceivers. This in turn is taken as indicative that the setup signaling is also interfering with and degrading performance on the already existing connections between mobile stations and transceivers in the network 15.

Accordingly, when the quality determiner 23 determines that the communication quality on the setup signaling channel is below a certain predefined threshold level of quality, the quality determiner 23 then notifies the setup controller via communication signal path 22, and the setup controller 21 responds to this notification by releasing the call. Thus, the determination that the communication quality on the setup signaling channel is below a certain predetermined threshold prevents the requested call from being admitted to the network. Because the call is released before the setup signaling is completed, the called party never knows that any call was ever attempted, and the calling party sees only that there is congestion in the network.

According to the invention, poor communication quality measured during setup signaling in the setup signaling channel is assumed to indicate that, if a traffic channel were assigned for communication between the mobile station and the transceiver, the traffic channel would also suffer from such poor quality. The poor quality indication also is assumed to indicate that, if the desired call is admitted, it will in turn interfere with the already existing connections in the network and degrade their quality, inasmuch as the already existing connections in the network are interfering with the setup signaling channel and degrading its quality.

FIGURES 3-7 illustrate the operation of various exemplary embodiments of the transceiver controller shown in FIGURE 2. Referencing FIGURE 3, after an available channel (e.g., SDCCH or TCH) is allocated at 31, the call setup signaling begins. The call setup signaling is represented in FIGURE 3 by decision block 33. More specifically, decision block 33 represents that setup signaling is ongoing until decision block 33 is answered "yes", at which point the call has been properly set up, so the conventional alert signal is sent to the called party at 32. The call will begin when the called party answers. The "no" path from decision block 33 is representative of the continuance of setup signaling on the setup signaling channel between the mobile station and the transceiver. Thus, while setup signaling is ongoing, both the transceiver 19 and the mobile station 16 provide at 34 conventional measures of the communication quality associated with the setup signaling channel, which measures are provided to the measurement storage section 25.

At 35, the quality determiner 23 of FIGURE 2 analyzes the quality measurements and evaluates the quality of communications on the setup signaling channel. At 36, the quality determiner compares the setup signaling channel communication quality with a predetermined threshold quality TH, which predetermined threshold can be advantageously determined from empirical studies of communication quality in the network. For example, in a GSM network, the quality determiner 23 could compare the bit error rate BER (as measured on uplink, downlink or both) to a predetermined bit error rate threshold which has been empirically determined from network studies to provide the desired admission control. If the quality of the setup signaling channel is lower than the predetermined threshold quality TH at 36, the quality determiner 23 communicates this to the setup controller 21 via communication signal path 22, and the setup controller responds at 37 by releasing the call. So long as the quality does not fall below the threshold quality at 36, the setup signaling, quality measurements and quality evaluation continue until either the setup signaling is successfully completed and the alert signal is sent at 32 or until the quality of the setup signaling channel is determined to fall below the predetermined threshold quality TH, resulting in release of the call at 37.

FIGURE 4 illustrates the operation of another exemplary embodiment of the controller of FIGURE 2. The operation of FIGURE 4 is the same as the shown in

FIGURE 3 through the quality evaluation step at 35. Thereafter, the exemplary embodiment of FIGURE 4 compares the measured quality of the setup signaling channel to an empirically determined threshold quality TH1 and, if the quality is less than the threshold TH1, then the call is released at 37. If the quality is not less than threshold TH1 at 41, then at 43 the quality determiner 23 determines whether the quality of the setup signaling channel is less than a second predetermined threshold quality TH2. If not, then the setup signaling, quality measurement and quality evaluation process is continued.

However, if the measured quality of the setup signaling channel is less than the threshold TH2, then the quality determiner 23 communicates this fact to the setup controller 21, whereupon the setup controller 21 causes another setup signaling channel to be allocated at 31. The procedure at 43 and 31 of allocating another channel when the quality of the current channel is below a predetermined threshold is a well-known conventional operation in the art.

The decision block 41 of FIGURE 4 represents a call admission decision which determines whether or not the call should be released, so the quality threshold TH1 preferably represents a lower level of quality than the quality threshold TH2. If the quality of the setup signaling channel is better than TH1, then the call will not be released. If the quality is less than TH2, then another setup signaling channel is allocated at 31. Otherwise, the setup signaling, quality measurement and quality evaluation procedure continues with the same channel.

FIGURE 5, when taken in combination with FIGURES 3 and 4, illustrates the operation of two further exemplary embodiments of the controller of FIGURE 2. In particular, the operation of FIGURE 5 provides an opportunity to release a newly requested call before the setup controller 21 allocates the setup signaling channel. When a mobile station requests a setup signaling channel at 51, the setup controller 21 of FIGURE 2 accesses the measurements storage section 25 to obtain therefrom quality measurements of idle traffic channels available in the network. Such quality measures of idle traffic channels are conventionally made by both mobile stations and transceivers. Examples of such conventional measurements are received signal strength indications (RSSIs) for both interference signals and carrier signals on the idle

traffic channels. These measures are conventionally used to determine a carrier-to-interference (C/I) ratio.

Although the aforementioned idle traffic channel measurements are conventionally used in making determinations of whether or not to change traffic channels, the embodiment of FIGURE 5 utilizes these idle traffic channel measurements as an indication of the level of interference currently existing in the network. Thus, the quality of the idle traffic channels is evaluated at 53 by the quality determiner 23 of FIGURE 2. If the quality determiner 23 determines that this quality measure is less than an empirically determined threshold quality TH3, then this fact is communicated from the quality determiner 23 to the setup controller 21, and the setup controller 21 releases the call at 37. However, if the quality of the network, as determined from the idle traffic channel measurements, is not found to be less than the threshold TH3, then this fact is indicated to the setup controller 21, whereupon the setup signaling channel is allocated at 31, and operations continue from block 31 of either FIGURE 3 or FIGURE 4.

FIGURE 6, when taken in combination with FIGURES 3 and 4, illustrates the operation of two further exemplary embodiments of the controller in FIGURE 2. When a mobile station has requested a setup signaling channel at 51 in FIGURE 6, the quality determiner 23 of FIGURE 2 obtains from the measurement storage section 25 the measurement reports provided by currently active connections in the network. Such measurement reports are well known and are conventionally received from both transceivers and mobile stations involved in active connections in the network. Examples of such measurement reports in a GSM system are the bit error rate measurements reported by the mobile stations and the transceivers involved in active connections. These measurements are evaluated at 61 by the quality determiner 23, and are taken as an estimate of the overall communication quality of the existing connections in the network. If at 65 the overall communication quality is found to be less than an empirically determined threshold quality level TH4, then this fact is communicated from the activity detector 23 to the setup controller 21, whereupon the setup controller 21 releases the call at 37. If the FIGURE 6 measure of communications quality in the network is not less than the empirically determined

threshold TH4 at 65, then a setup signaling channel is allocated at 31, and operations proceed from block 31 of either FIGURE 3 or FIGURE 4.

FIGURE 7, when taken in combination with FIGURES 3 and 4, illustrates operations of two further exemplary embodiments of the controller of FIGURE 2. In FIGURE 7, when a mobile station has requested a setup signaling channel at 51, the quality determiner 23 obtains from the measurement storage section 25 information about traffic loading in the network. This information is evaluated at 71 by the quality determiner 23. The traffic load of the transceiver(s) associated with the controller is of course known to the controller, and the traffic load of neighboring controllers (for example in neighboring cells of a GSM cellular network) is available via conventional communication signal paths (not shown) coupling the transceiver controllers of the network (for example, BSCs in GSM) to one another. In the operation of FIGURE 7, the traffic loading information is taken to be representative of the current communication quality of the network. If this quality is less than an empirically determined threshold level of quality TH5 at 73, then this fact is communicated from quality determiner 23 to setup controller 21, whereupon setup controller 21 releases the call at 37. Otherwise, the setup controller 21 allocates the setup signaling channel at 31, and operations proceed from block 31 in either FIGURE 3 or FIGURE 4.

It should be clear from the foregoing that, according to the present invention, when a call is setup on a signaling channel, the communication quality measurements for that signaling channel, as reported by the mobile station and the transceiver, are evaluated. Thus, information is obtained on the actual downlink and uplink interference experienced by that mobile station when communicating with the selected transceiver. Moreover, if a traffic channel is assigned for the setup signaling, then quality information is obtained for the actual traffic channel on which the call, if admitted, would proceed. This quality information is used to decide whether or not the call should be admitted. If the information indicates that the quality is too low, then the chance of the call/connection surviving is relatively small, and/or, the probability that the requested call will generate an unacceptable level of interference to existing connections associated with neighboring transceivers (e.g., in other GSM cells) is relatively high. In these circumstances, the setup controller will release the call. To the calling party, the operation of the present invention will appear as a

normal congestion problem, because no traffic channel is ever assigned for the call itself. The called party will never know a call was requested.

The invention thus provides admission control based on information that is more relevant than that used in the prior art, and the admission control according to the present invention can lead to better channel utilization. The invention will also reduce instances of the annoying problem of dropping recently established connections due to poor quality in the connection.

It will be evident to workers in the art that the embodiments of FIGURES 2-7 can be readily implemented in software, hardware, or a suitable combination of software and hardware, in a transceiver controller of a wireless communication network, for example, a base station controller (BSC) of a GSM network.

Although exemplary embodiments of the present invention have been described above in detail, this does not limit the scope of the invention, which can be practiced in a variety of embodiments.

WHAT IS CLAIMED IS:

1. A method of controlling call admission operations in a wireless communications network, comprising:

receiving a request for a call that requires communication between a fixed-site radio transceiver and a mobile radio transceiver;

performing communications between the fixed-site radio transceiver and the mobile radio transceiver on a selected communications channel;

measuring communication quality of the communications on the selected communication channel during the performance of communications on the selected communication channel; and

deciding in response to the measured communication quality whether to admit the requested call into the network.

2. The method of Claim 1, wherein said deciding step includes comparing the measured communication quality to a threshold level of communication quality.

3. The method of Claim 1, including selectively admitting the requested call in response to said deciding step, said selectively admitting step including selectively assigning the call to a traffic channel.

4. The method of Claim 3, wherein the selected communication channel is a control channel.

5. The method of Claim 3, wherein the assigned traffic channel is the selected communication channel.

6. The method of Claim 1, wherein the requested call includes a voice communication.

7. The method of Claim 1, wherein the requested call includes a data communication.

8. The method of Claim 1, wherein the wireless communication network is a GSM network.

9. A method for controlling admission of calls in a wireless communication network, comprising:

performing on a selected channel setup signaling for a desired call;

obtaining during the setup signaling information indicative of communication quality on the selected channel during the setup signaling; and

deciding in response to said information whether to admit the desired call into the network.

10. The method of Claim 9, wherein said performing step includes performing setup signaling on a control channel.

11. The method of Claim 10, wherein the wireless communication network is a GSM network, and wherein said performing step includes performing the setup signaling on a stand-alone control channel (SDCCH).

12. The method of Claim 9, wherein said performing step includes performing the setup signaling on a traffic channel.

13. The method of Claim 9, wherein said obtaining step includes measuring a bit error rate of the selected channel during the setup signaling.

14. The method of Claim 13, wherein said measuring step includes measuring the bit error rate of the selected channel at one of a fixed-site radio transceiver and a mobile radio transceiver.

15. The method of Claim 14, wherein said measuring step includes measuring the bit error rate of the selected channel at both the fixed-site radio transceiver and the mobile radio transceiver.

16. The method of Claim 13, wherein said deciding step includes comparing the bit error rate on the selected channel to a threshold bit error rate.

17. The method of Claim 9, wherein said deciding step includes comparing the communication quality of the selected channel to a threshold level of communication quality.

18. The method of Claim 9, including obtaining traffic loading information indicative of traffic loading in the network, and deciding in response to the traffic loading information whether to perform the setup signaling.

19. The method of Claim 9, including obtaining idle channel information indicative of communication quality on idle traffic channels in the network, and deciding in response to the idle channel information whether to perform the setup signaling.

20. The method of Claim 9, including obtaining active connection information indicate of communication quality associated with active communication connections in the network, and deciding in response to said active connection information whether to perform the setup signaling.

21. The method of Claim 9, wherein the desired call includes a voice communication.

22. The method of Claim 9, wherein the desired call includes a data communication.

23. An apparatus for controlling admission of calls into a wireless communication network, comprising:

an input for receiving information indicative of communication quality on a selected channel and obtained during setup signaling performed on the selected channel for a desired call; and

a determiner coupled to said input and responsive to said information for deciding whether to admit the desired call into the network.

24. The apparatus of Claim 23, wherein the desired call includes a voice communication.

25. The apparatus of Claim 23, wherein the desired call includes a data communication.

26. The apparatus of Claim 23, wherein the wireless communication network is a GSM network.

27. A wireless communications network, comprising:

a plurality of fixed-site radio transceivers for radio communication with a plurality of mobile radio transceivers via a plurality of channels; and

an apparatus for controlling admission of calls into the network, said apparatus having an input coupled to one of said fixed-site radio transceivers for receiving therefrom information indicative of communication quality on a selected said channel and obtained during setup signaling performed on the selected channel for a desired call, said apparatus including a determiner coupled to said input and responsive to said information for deciding whether to admit the desired call into the network.

28. The network of Claim 27, wherein said network is a GSM network, and said apparatus forms a portion of a base station controller of said GSM network.

29. The network of Claim 27, wherein the desired call includes a voice communication.

30. The network of Claim 27, wherein the desired call includes a data communication.

FIG. 1

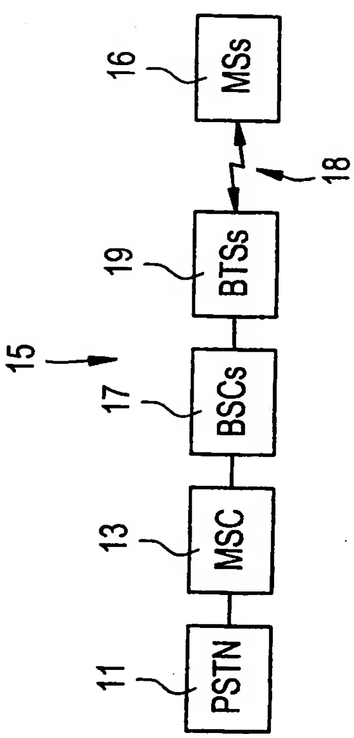

15
11
PSTN
13
MSC
17
BSCs
19
BTSs
18
16
MSs

FIG. 2

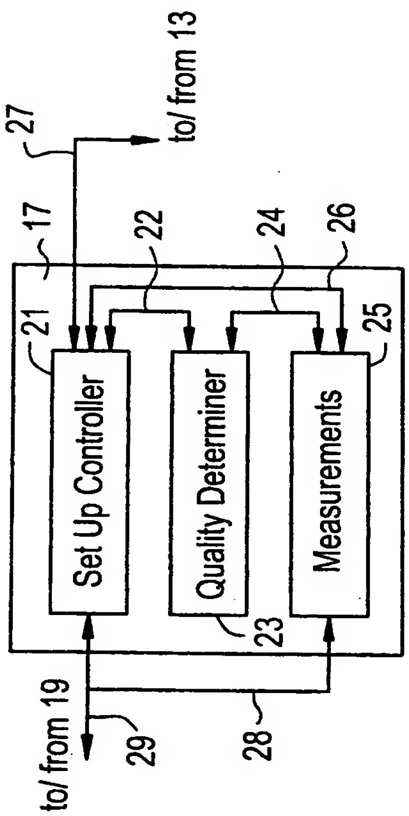

27
to/ from 13
17
22
24
26
21
Set Up Controller
Quality Determiner
23
Measurements
25
to/ from 19
29
28

FIG. 3

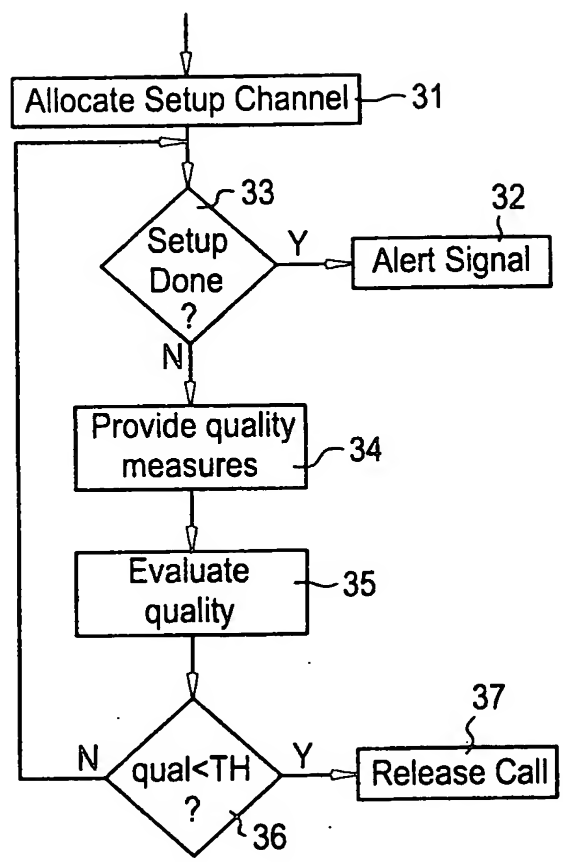

Allocate Setup Channel
31
33
32
Setup Done ?
Y
Alert Signal
N
Provide quality measures
34
Evaluate quality
35
37
N
qual<TH ?
Y
Release Call
36

FIG. 4

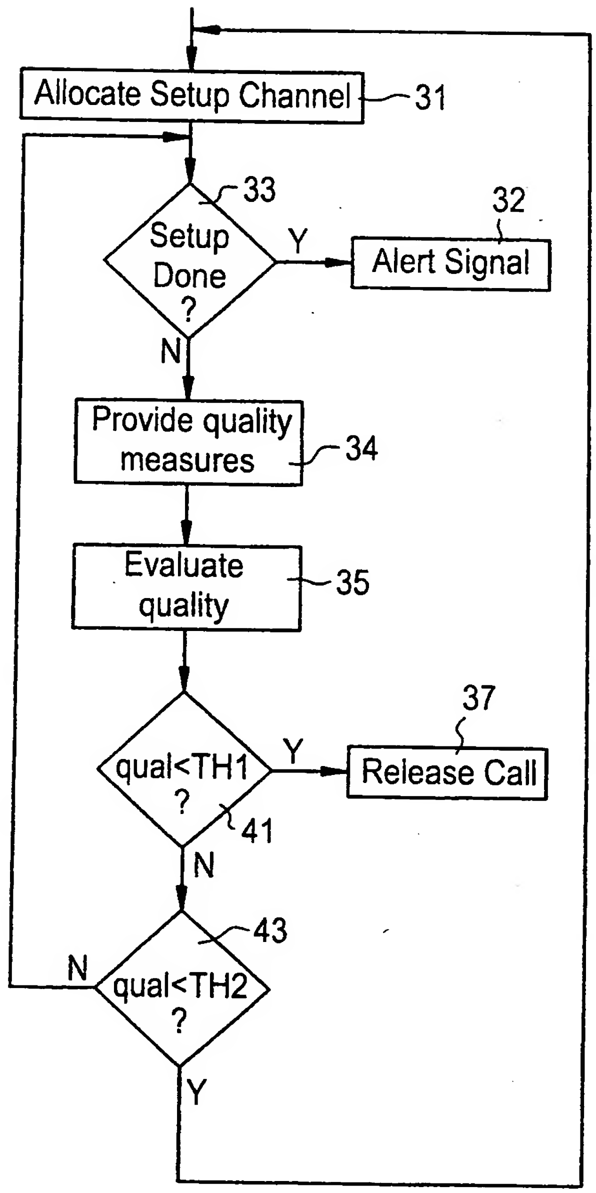

Allocate Setup Channel
31
33
Setup Done ?
Y
32
Alert Signal
N
Provide quality measures
34
Evaluate quality
35
37
qual<TH1 ?
Y
Release Call
41
N
43
N
qual<TH2 ?
Y

FIG. 5

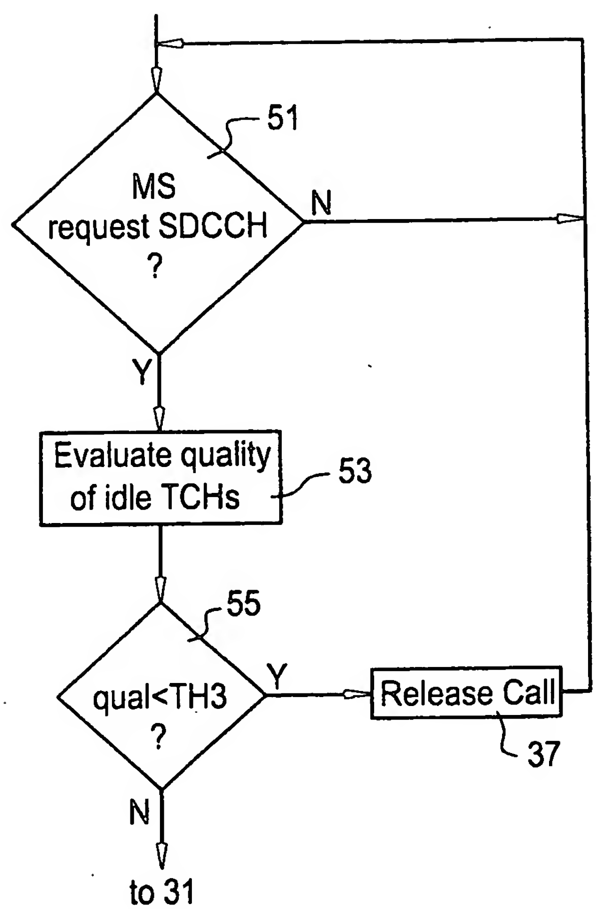

51
MS request SDCCH ?
N
Y
Evaluate quality of idle TCHs
53
55
qual<TH3 ?
Y
Release Call
37
N
to 31

FIG. 6

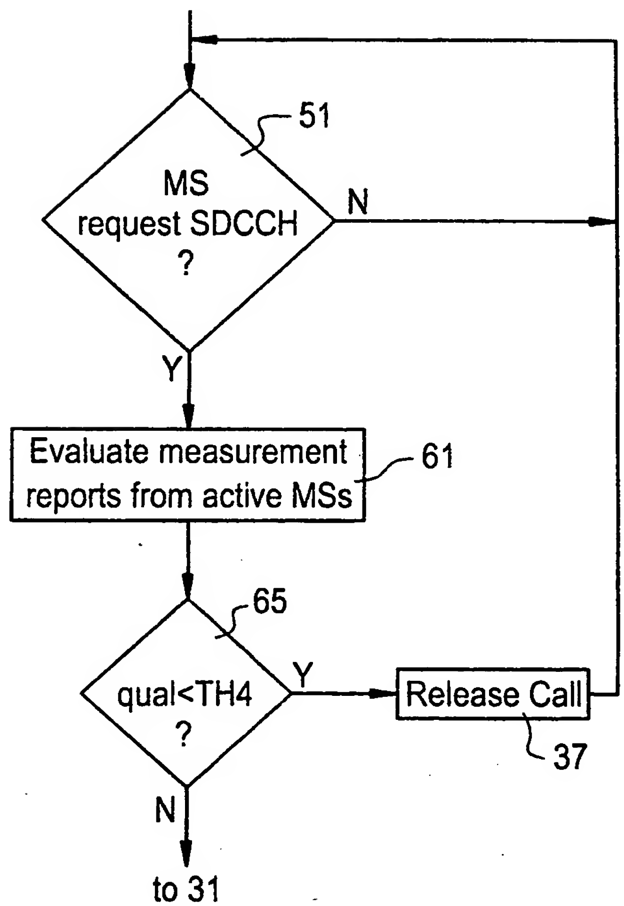
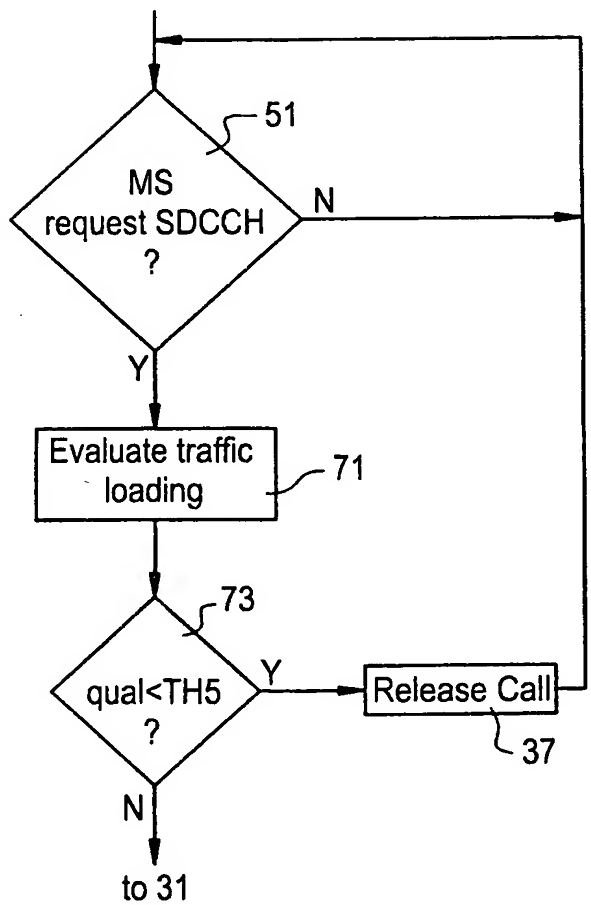

51
MS request SDCCH ?
N
Y
Evaluate measurement reports from active MSs
61
65
qual<TH4 ?
Y
Release Call
37
N
to 31

FIG. 7


51
MS
request SDCCH
?
N
Y
Evaluate traffic
loading
71
73
qual<TH5
?
Y
Release Call
37
N
to 31

INTERNATIONAL SEARCH REPORT

International Application No
PCT/SE 99/00998

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04Q7/38

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 97 33449 A (ERICSSON TELEFON AB L M) 12 September 1997 (1997-09-12) page 8, line 12 -page 9, line 23 page 10, line 29 -page 11, line 17 page 11, line 33 -page 12, line 2	1-3,5,6, 9,12,17, 21,23, 24,27,29
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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
6 October 1999	15/10/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Schut, G

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Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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